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Growth and Quality of Red Oak Planted in Red Pine Plantation Openings

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Abstract

Ninety-eight percent of red oak nursery stock survived following planting in openings of a mature red pine plantation. Of these 61% produced an average height of 3 m in 10 years and exhibited good stem quality. Planting of red oak as an admixture in stand conversions is recommended.

Growth and Quality of Red Oak Planted in Red Pine Plantation Openings

Introduction

Northern red oak (Quercus rubra L.) is one of the major species in the northern mixedwood and hardwood cover types of Ontario. Its high market value and domestic demand, which is expected to double by the year 2025 (OMNR 1982), make the regeneration and management of red oak an economically attractive investment. The value of red oak is 30% higher than its main associate sugar maple (Acer saccharum March.) (OMNR 1985). Logs of red oak and white oak (Q. alba L.), along with yellow birch (Betula alleghaniensis Britton) and sugar maple are now being imported into Ontario from the United States (Blyth and Smith 1984, Nevel et. al 1982). Thus, it would be beneficial to increase, among other, the amount of red oak growing in Ontario, where once large quantities of quality red oak existed.

In southern Ontario forests there are few successful red oak plantings, only two of which have been documented (Stroempl and Beckwith 1978, Stroempl 1987). In this note one of several planting trials in the forest districts of Algonquin and Central regions of Ontario is discussed. The purpose of these trials is to test the survival and potential growth of red oak nursery stock that has been planted under a variety of stand conditions.

Materials and Methods

The red pine plantation used in this study is part of Hendrie Forest in the Huronia Forest District, Vespra Township (lat. 44° 25' long. 79° 44'), Ontario. The site is a well-drained, slightly acid, stonefree sandy loam to loamy sand of the Tioga series, developed on deep somewhat calcareous outwash sand (Hoffman and Wicklund 1962). The topography is level to gently rolling. The pH was 4.3 and 6.2 in the humus and mineral soil, respectively.

The red pine plantation was established in 1948 at 2 x 2 m spacing and developed into a fully stocked stand. Three large and four small nearly circular openings which had been accidentally created since 1965, were used in this study. The openings varied from 0.020 ha (small) to 0.035 ha (large) in size (Fig. 1). The large openings had been invaded by dense shrubs of raspberries (Rubus spp.) and sumac (Rhus typhina L.) while the small openings were void of shrub vegetation.

The 2+0 red oak nursery stock with an average height of 40 cm was grown at Orono nursery. The roots of the stock were pruned to about 20 cm from the root collar at the time of planting as recommended by several investigators (Johnson 1984, Olson 1972, Russell 1973, Stroempl 1985). A total of 780 seedlings were "deep" planted (i.e., up to a depth of 7 cm above the root collar), using the half-hole method (USDA 1984) with standard fire shovels, at a spacing of 1.5 m x 1.5 m. Planting was done on May 10 and 11, 1977 under cloudy weather conditions.

The tenth year data on survival, height and stem quality of planted oak were analyzed by the standard t-test at 1% and 5% level of significance. The criteria used for assessing quality of oak are given in Table 1.

Figure 1. A 1977 red oak planting in one of the red pine plantation openings in Hendrie Forest, as seen in August 1983.

TABLE 1. Quality criteria for assessing tree class, crown position and damage to the planted oak.

Good	Crown dominant or codominant	Top broken with one lateral assuming apical dominance. High double fork at top or upper one-half of stem height. Previous stem defect still identifiable.
Fair	Crown intermediate, partially suppressed *(by neighbouring planted or natural oaks)	Flat crown. Top broken with apical dominance yet undetermined. Multiple high forks. Low fork with one stem vigorous. Previous stem defect prominent.
Poor	Crown suppressed *(as above)	Top broken, no recovery. Low fork, poor vigour. Severe defect at stem base and poor to no resprouting.

\+ Includes few trees with insignificant damage of excellent recovery.
++ Includes damage persisting for several years or recent damage.

Results

The survival of planted oak was 98%, of which 65% exhibited good growth (Table 2). The difference in survival between opening sizes in relation to quality classes "good", "fair" and "poor" was not statistically significant.

The average height growth for each of the 3 quality classes was significantly better (at 1% level) in the large openings than in the small ones (Table 3). Height differences among quality classes were significant (at 1% level) within the openings as well. The best average height of 3.4 m and 2.4 m was exhibited by good trees in the large and small openings, respectively.

The maximum height of a good tree was 6.3 m and 4.4 m and that of a fair tree 3.2 m and 1.5 m in the large and small openings, respectively.

Trees with damage in Table 2 were assessed separately by 3 types of damage in Table 4. Damage to tops of good, fair and poor trees was more frequent than forking (as a result of recovery) or base damage (early browsing). However, 58% of poor trees suffered base damage in both opening sizes, but those in the large ones recovered by producing sprouts more than twice the height of those in the small ones (Table 5).

TABLE 2. Survival and stem quality of red oak planted in red pine plantation openings (average data 1977-86).

Size of stand openings	No. oak planted	Percent of quality classes by openings						Survival percent
		Good	Good +damage	Fair	Fair +damage	Poor	Poor +damage	
Large	410	63	2	12	11	7	3	98
Small	370	60	4	10	10	11	3	98

TABLE 3. Height growth of red oak planted in red pine plantation openings.

Size of stand openings	Height (m) of quality classes by openings					
	Good	Good +damage	Fair	Fair +damage	Poor	Poor +damage
Large	3.4a	2.7a*ab	2.2ab	2.4ab	1.3ab	1.3ab
Small	2.4a*ab	2.1ab	1.1ab	1.5ab	0.6b	0.6b

Means with different letters are statistically significant at 1% level or 5% level* of probability within and between the same sizes of openings.

TABLE 4. Quality of damaged planted red oak in relation to type of damage and opening size (1977-1986).

Type+ of damage	Percent of quality classes by type of damage and openings							
	Good		Fair		Poor		All	
	Large	Small	Large	Small	Large	Small	Large	Small
Top	62	53	62	55	42	37	55	48
Fork	20	20	16	19	0	0	12	13
Base	20	27	22	26	58	58	33	37

+ Damage as a result of previous girdling, clipping or browsing.

The average height of damaged trees in all 3 quality classes was better in the large openings than in the small ones (Table 5). The difference in average height for all trees in the large versus small openings of respectively 2.1 m and 1.4 m is significant at 1% level. Good trees with forks reached 3.2 m in the large openings compared to the average for the good class of 3.4 m (Table 3). It is interesting to note that 'fair' trees with forks or damaged tops reached 2.5 m or 1.5 m in the large and small openings, respectively, exhibiting somewhat better growth compared to the average height values for the fair quality class of 2.2 m or 1.1 m (Table 3) which included all trees. This suggests that assessing 'fair' trees (Table 3) was sometimes problematic because those with detectable previous damage had better height than those without, implying that forking or top damage,presumably due to infrequent browsing, encouraged vigorous apical growth of one side shoot.

TABLE 5. Height of damaged planted red oak in relation to type of damage and opening size (1977-1986).

Type+ of damage	Height (m) of quality classes by type of damage and openings							
	Good		Fair		Poor		All	
	Large	Small	Large	Small	Large	Small	Large	Small
Top	2.7a*	2.1	2.5a	1.5b	1.6a	0.9b	2.3a	1.5b
Fork	3.2	2.4	2.5a	1.5b	-	1.4	2.7a	1.7b
Base	2.1	1.8	2.0a	1.3b	1.1a	0.4b	1.5a	1.0b
All	2.7a	2.1b	2.4a	1.5b	1.1a	0.6b	2.1a	1.4b

+ Damage as a result of previous girdling, clipping or browsing.
Means with different letters are stat. significant at 1% level or 5% level*.

Discussion and Recommendations

Planting of red oak seedlings in openings resulted in good survival, height and stem quality after 10 years in a mature red pine plantation. Although survival was equally high in all openings, height growth was significantly less in the smaller openings, probably due to lower light intensities. Repeated rodent girdling or clipping and deer browsing to oak during earlier years of growth were the main causes of damage limiting the number of good trees and the recovery of their crowns, or resprouting. However, partial damage during later years seemed to encourage vigorous apical growth of one shoot or resprouting at base of the stem, particularly in the larger openings.

The size of the openings is important as it limits the amount of light that can penetrate through the sheltering stand from the sides or above, while the shape of the opening is not as important. For example, red oak, interplanted with white pine in corridors 4.5 m wide following double-row thinning in a 20-year-old Scots pine plantation, is developing well where browsing is infrequent (Deugo 1986)[1]. Others prefer group-planting of red oak in pine stands to avoid partial suppression at margins of the protective sheltering stand and subsequently easier tending compared to long intermittent rows of one or two species (Mayer 1977). The free-to-grow stage is usually reached earlier in group plantings.

Repeated animal damage may require measures of control until the free-to-grow stage of oak saplings, i.e., about 2 m in height, to minimize damage and enhance early vigour of a greater number of oak trees in similar plantings. One suggested treatment is the creation of temporary feeding yards to divert deer from browsing the planted oak (Deugo 1986).

Natural red oak of good quality, occurring in the surrounding plantations under a variety of canopy closures, often with advanced reproduction of hardwoods and white pine, emphasizes the wide tolerance of red oak and its suitability to grow well on apparently 'red pine sites'. This study illustrates that red oak planted in red pine plantation openings will survive and grow well, provided that animal damage is not serious.

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